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<p>(21) International Application Number: <b>PCT/SE97/01992</b></p> <p>(22) International Filing Date: <b>27 November 1997 (27.11.97)</b></p> <p>(30) Priority Data: <b>08/755,572</b> 27 November 1996 (27.11.96) US</p> <p>(71) Applicant: <b>TELEFONAKTIEBOLAGET LM ERICSSON</b> (publ) [SE/SE]; S-126 25 Stockholm (SE).</p> <p>(72) Inventor: <b>TURINA, Dalibor</b>; Redutvägen 14B, S-187 68 Täby (SE).</p> <p>(74) Agent: <b>TELEFONAKTIEBOLAGET LM ERICSSON</b>; Patent and Trademark Dept., S-126 25 Stockholm (SE).</p>		<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p> <p>(88) Date of publication of the international search report: <b>1 October 1998 (01.10.98)</b></p>	
<p>(54) Title: <b>METHOD AND APPARATUS FOR IMPROVING PERFORMANCE OF A PACKET COMMUNICATIONS SYSTEM</b></p> <p><b>TDMA Frame</b></p> <p>downlink</p> <p>uplink</p> <p>0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7</p> <p>0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7 0 1 2 3 4 5 6 7</p> <p>■ timeslots reserved for VIP MS</p> <p>▨ timeslots that may be reserved for other packet traffic</p>			
<p>(57) Abstract</p> <p>A communications system (10) is provided that uses a multiple access packet reservation type of protocol. The physical channels required for the packet transfers are specially allocated to one mobile station (16) (referred to as a "VIP MS"). The VIP MS (16) has the exclusive priority to use these allocated physical channels for packet data as needed. Consequently, the VIP MS (16) always has the negotiated bandwidth available for the packet transfers. Furthermore, since the VIP MS (16) is given the highest exclusive priority to access these physical channels ("VIP priority"), by allocating a reserved random access channel dedicated to the VIP MS (e.g., on one allocated uplink channel), the variable random access delays experienced by prior systems no longer exist. Since the VIP MS (16) is always scheduled first for transmissions on the downlink, and reserved access is provided for the VIP MS (16) on the uplink, only a constant delay period for the uplink and downlink is involved. In other words, the VIP MS (16) is guaranteed both a bandwidth for the packet transfers and a constant uplink and downlink delay.</p>			

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# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/SE 97/01992

**A. CLASSIFICATION OF SUBJECT MATTER**

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According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 H04Q H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 096, no. 010, 31 October 1996 & JP 08 154097 A (NIPPON TELEGR &AMP;TELEPH CORP &LT;NTT&GT;) see abstract --- WO 96 37079 A (QUALCOMM INC) 21 November 1996 see page 5, line 26 - page 6, line 6 see page 6, line 17 - line 30 see page 9, line 27 - page 10, line 2 see page 11, line 18 - line 29 see page 18, line 31 - page 19, line 13 see page 42, line 3 - page 43, line 24 --- -/-	1,2,16, 19,25
A		1,2,16, 19,25

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

\* Special categories of cited documents :

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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "Z" document member of the same patent family

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040. Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Gerling, J.C.J.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>BIANCHI G ET AL: "DYNAMIC CHANNEL ALLOCATION PROCEDURES FOR PACKET DATA SERVICES OVER GSM NETWORKS"          ISS '95. WORLD TELECOMMUNICATIONS CONGRESS. (INTERNATIONAL SWITCHING SYMPOSIUM), ADVANCED SWITCHING TECHNOLOGIES FOR UNIVERSAL TELECOMMUNICATIONS AT THE BEGINNING OF THE 21ST. CENTURY BERLIN, APR. 23 - 28, 1995, vol. 1, 23 April 1995, pages 246-250,          XP000495573          VERBAND DEUTSCHER ELEKTROTECHNIKER (VDE)          ET AL          see page 246, right-hand column, paragraph 2 - page 247, right-hand column, paragraph 3          see page 248, left-hand column, line 44 - line 58          see page 249, right-hand column, paragraph 5 - page 250, left-hand column, line 3          ---</p>	1,2,16, 19,25
A	<p>EP 0 681 406 A (NOKIA MOBILE PHONES LTD) 8 November 1995          see column 3, line 45 - column 4, line 20          see column 11, line 9 - line 50          ---</p>	1,2,16, 19,25
A	<p>EP 0 687 078 A (NOKIA MOBILE PHONES LTD) 13 December 1995          see column 3, line 51 - column 4, line 14          see column 4, line 34 - line 40          see column 8, line 5 - line 40          see column 10, line 13 - column 12, line 31          -----</p>	1,2,16, 19,25

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/SE 97/01992

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
WO 9637079	A	21-11-1996		US 5673259 A AU 5859596 A EP 0827674 A FI 974215 A		30-09-1997 29-11-1996 11-03-1998 16-01-1998
EP 0681406	A	08-11-1995		FI 942038 A AU 1785795 A CN 1112346 A US 5640395 A		04-11-1995 09-11-1995 22-11-1995 17-06-1997
EP 0687078	A	13-12-1995		FI 942702 A CN 1115164 A JP 7336774 A US 5729541 A		09-12-1995 17-01-1996 22-12-1995 17-03-1998

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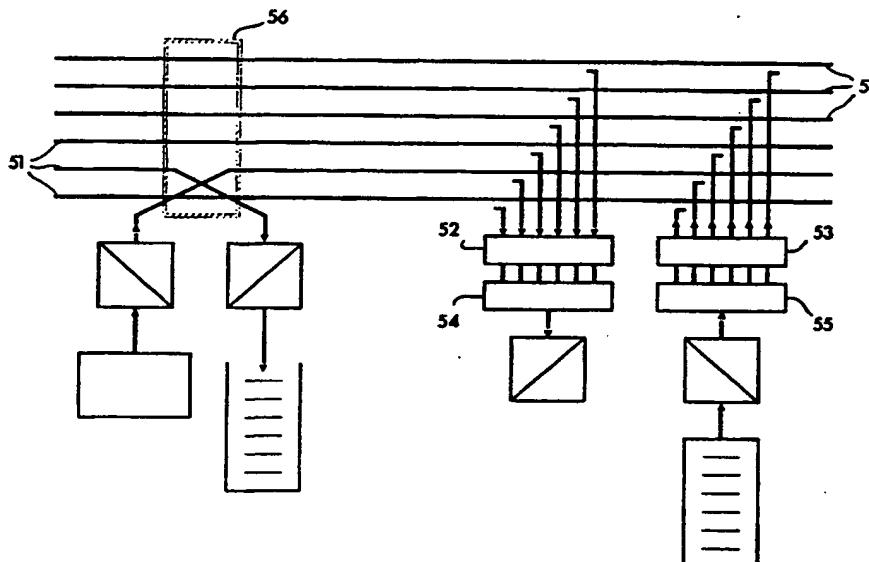
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(71) Applicant (for all designated States except US):	INTERNATIONAL BUSINESS MACHINES CORPORATION [US/US]; Old Orchard Road, Armonk, NY 10504 (US).		
(72) Inventors; and			
(75) Inventors/Applicants (for US only):	VAN AS, Harmen, R. [NL/CH]; Wieswaldweg 13, CH-8135 Langnau am Albis (CH). SCHINDLER, Hans, R. [CH/CH]; Wildenbühlstrasse 40, CH-8135 Langnau am Albis (CH).		
(74) Agent:	BARTH, Carl, O.; International Business Machines Corporation, Säumerstrasse 4, CH-8803 Rüschlikon (CH).		

(54) Title: ACCESS CONTROL SYSTEM FOR A MULTI-CHANNEL TRANSMISSION RING



(57) Abstract

A node for an access control system for a multi-channel data transmission ring is disclosed, wherein the access to a channel is controlled exclusively by one node, which also is the only data receiving node connected to that channel. The node is characterized by having means to generate slots to which the other connected nodes transfer data having said node as receiving node and further means to achieve a balanced access to the channel by all connected nodes. Further embodiments of the invention include means to prevent a congestion in the buffer of the receiving node. The invention is especially designed for wavelength division multiplexed (WDM) optical rings.

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**DESCRIPTION**

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**Access Control System for a Multi-Channel Transmission Ring**

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The invention relates to an access control system for a multi-channel digital data transmission ring, especially for an optical ring with wavelength division multiplexing, in which a user or node is exclusively assigned as a data receiving user or node to each of the channels. In particular, the invention pertains to a node applicable in the described access control system.

15

**BACKGROUND OF THE INVENTION**

20

The technical field of the invention relates to communication networks for digital data transmission having a multi-channel ring topology. The networks referred to are known under the abbreviation LAN for Local Area Network, MAN for Metropolitan Area Network, and to a certain extent as WAN for Wide Area Network, respectively.

25

In a communication network, multiple users or nodes are interconnected by at least one transmission medium. In a ring topology, all node-to-node connections form together a circle through which the data are passed from a transmitting to a receiving node. Rings can be realized using transmission media like twisted pairs of wire, coaxial cables, or optical fibers. Several well known techniques can be employed to establish a multi-channel ring: The simplest approach is to use a number of parallel cables or fibers to interconnect the users of the ring. Another approach utilizes multiplexing techniques. In multiplexing, a common physical connection is shared between the users by dividing, for instance, the available bandwidth of a transmitting medium into fractions exclusively accessible by one user, these fractions being either frequency fractions (frequency division multiplexing or FDM) or

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**SUBSTITUTE SHEET**

- 1 fractions of the complete bandwidth (time division multiplexing or TDM) referred to as time slots. The fraction of the total bandwidth is also referred to as logical channel in contrast to the physical "real" channel. While in electrical signal transmission the frequency multiplexing scheme is known as
- 5 frequency division multiplexing, in optical networks the term wavelength division multiplexing (WDM) is preferred.
- A WDM ring is described in the European patent application EP-A-0520492. From this application, a data transmission system is known, wherein each node is assigned to a wavelength different from other nodes, so, when it
- 10 detects data on said wavelength, it receives said data for data processing, while data on other wavelengths are passed through. When the node transmits data to one of the other nodes, it generates data having the wavelength assigned to this destination node. Thus, every wavelength has the meaning of an address of the destination node. Further, to every node on the
- 15 ring at least one time slot for each wavelength is assigned. Thus, the data transfer is strictly pre-coordinated or synchronized. While effectively preventing a collision of data transmitted to the channel, the fixed pre-coordination deteriorates the throughput of the channel, as transmitting users cannot take advantage of free time slots assigned to other nodes.
- 20 The method used in EP-A-0520492 and other methods allowing participation of multiple users in a network are generally known as medium access control (MAC) protocols. A MAC protocol serves to control the access of the users to the network, to direct the data from the sending or calling user to the receiving user, to prevent the loss of data, and the like. A major task of such
- 25 a protocol is to guarantee a fair access of all users or nodes to the connecting network by predetermined criteria. These criteria may include the designation of priorities to certain nodes, the balance between heavy users of the network and occasional users, and managing access loads that exceed the maximum throughput of the network.
- 30 An approach (static FDM or TDM) in a MAC is to assign a portion of the transmission capacity to a certain user. However, static assignment is well known for its poor performance. Due to that reason, much work has been

- 1 concentrated on dynamic bandwidth allocation methods. Two medium access  
schemes have won dominance in the art, one of which is based on random  
access Carrier Sense Multiple Access (CSMA) type protocols while the other  
scheme is characterized by controlled access token-passing type protocols.
- 5 Furthermore, a slotted transmission structure is known, for example, from a  
reservation based MAC protocol, i.e. the Cyclic Reservation Multiple Access  
(CRMA) protocol, which supports any combination of frame-oriented LAN and  
cell-oriented asynchronous transfer mode (ATM) data transmission. A CRMA  
protocol for bus topologies is described, for example, by M.M. Nassehi in:
- 10 Eighth Annual EFOC/LAN Conference, Munich, June 1990, paper 5.3.4, pp.  
246-251. In CRMA, one node, i.e the headend or scheduler, issues  
continuously slots, identified by a start/end delimiter pair or by a  
characteristic header sequence. The transmitting nodes of the network  
transfer the data cells or frames into said slots, together with two address  
15 labels, indicating the source and the destination of the data. The CRMA  
protocol includes a reservation based fairness scheme to prevent that the first  
nodes of the network are occupying exclusively the slots.
- It is an object of the invention to provide means to control the access of  
multiple users or nodes to a slotted transmission medium divided into  
20 different channels, wherein each node is assigned to one channel as receiving  
node. More specifically, the invention provides means for multiple access  
control ensuring fairness, data flow, and congestion control. A particular  
object of the invention is to provide such means for an optical ring using  
wavelength division multiplexing. These and further objects of the invention  
25 will become apparent from the following description of the invention.

#### SUMMARY OF THE INVENTION

- 30 According to the invention, a node in the described digital data transmission  
system comprises first means to transmit data to channels assigned to other  
nodes, second means to generate slots in which the other nodes can

- 1   asynchronously insert the data to be transmitted to said node, said slots having at least one bit indicating a busy/free status which is set by the transmitting node, and third fairness control means to provide a balanced access to said slots to all nodes having data to transmit on said channel in
- 5   case of the amount of data to be transmitted exceeds the capacity of said channel.

Thus, a node which controls a channel provides the slots into which the transmitting nodes insert the data designated to said node. As mentioned above, slots are identified by a start/end delimiter pair or by a characteristic header sequence. In contrast to the known access schemes for transmission media divided into channels controlled by different nodes, which only allow strictly synchronized data transmission in preassigned slots, as described in EP-A-0520492, the transmitting nodes according to the invention are allowed to transmit their data into any passing unoccupied slot, unless the capacity of the channel is exceeded. The status of a slot is indicated by an appropriate setting of the busy/free bit. The transmitting node sets the busy/free bit and, hence, prevents that other transmitting nodes try to gain access to the occupied slot. The asynchronous access exploits the capacity of a channel generally better than the strictly synchronized data transmission, in which the time slot assigned to one transmitting node cannot be occupied by another node.

In order to prevent an unbalance in access opportunities between the transmitting nodes for the generated slots in case that the amount of data to be transmitted is exceeding the capacity of the channel, each channel controlling node is provided with fairness control means, preferably comprising means to periodical generate a poll slot (reserve command). The time between two consecutive reserve commands or the number of slots generated between the two reserve commands is defined as reservation cycle. The reserve command serves two purposes: Firstly, it notifies a fairness threshold value (TH) for the immediately following reservation cycle to the nodes which are currently tuned to its channel, i.e. the nodes which want to transmit data to the channel controlling destination node. Secondly, the

1 reserve command gathers a value (QL) indicating the amount of data to be  
transmitted on the considered channel from each of the nodes tuned to that  
channel. The QL values are used to determine the threshold value (TH) for  
the next reserve command. If the demand does not exceed the capacity of the  
5 channel, the threshold value is set to a number, e.g. 0, indicating that the  
nodes are free to access as many of the passing unoccupied slots as required.  
If, however, the summed demand exceeds the capacity of the channel, the  
slots generated during the following cycle are marked as reserved by setting  
another bit, i.e. the reserve bit, within each slot. As a transmitting node, each  
10 node comprises further means to determine the amount of data allowed to be  
transmitted to another node according to the threshold value (TH) received by  
the node which controls the channel.

In another preferred embodiment of the invention, a node comprises a buffer,  
in which the data received from the medium can be stored. To prevent an  
15 overflow of the receiver buffer, flow control means monitor the extent to which  
the buffer is filled and throttle the generation of free slots, accordingly. The  
signal to throttle the free slot generation might as well be triggered from  
another circuitry the capacity of which being stressed critically. It is an  
advantage of the invention that the flow control on the transmission medium is  
20 achievable by simply marking part of the generated slots as busy, thus,  
preventing an access of transmitting nodes.

In addition to the flow control or instead of it, a node preferably comprises  
congestion control means, which also depends on the grade to which said  
buffer means is occupied and is using the channel as an intermediate storage.  
25 A possible way to exploit the transmission medium as an intermediate  
storage, according to the invention, is to let the channel controlling node  
generate a specific slot (congestion command) which causes all nodes to stop  
transmission on its channel. The incoming occupied slots are relayed back to  
the transmission medium. In case of an optical transmission medium, the  
30 slots are either reverted to the ring before the opto-electrical conversion by a  
switch controlled through the congestion control or by using the slot  
generator to reconstruct the received slots after opto-electrical conversion and

- 1 feed these slots back to the ring by the same means as applied to freshly generated slots.
- 5 In many applications, specific priority schemes are required to control the access to the transmission medium according to different functions of the connected nodes, e.g. in real time applications like voice and video transmission. For example, in voice transmission, a node demands a guaranteed bandwidth to prevent a distortion or an interruption of the transmitted speech. To allocate a demand for guaranteed slots dynamically, i.e. according to the actual need, a node comprises priority access control
- 10 means or guaranteed bandwidth control means periodically generating a poll slot (priority or guarantee command) to collect the demand for priority or guaranteed bandwidth slots to be transmitted on its channel node from each of the other nodes tuned to that channel. According to the number of requested priority or guaranteed slots and the capacity of its channel, the slot
- 15 generator produces slots marked by special bits as priority or guaranteed slots. If both types of slots are requested, the guaranteed slots should preferably be generated before the priority slots. The nodes monitor the passing slots and occupy the first free priority or guaranteed slots with their data.
- 20 As in periods of high data traffic on a channel, almost every generated slot will be marked according to the invention as priority slot, as guaranteed, or as reserved, and as there is necessarily a delay of one round-trip between the reported demand and the generation of the respective slots, a node may have a reduced QL or even no data to transmit at the arrival of the slots demanded
- 25 through the last polling. To maintain nevertheless a high throughput, the generated slots preferably have at least another bit (release bit) to cancel the effect of the reservation and free the unoccupied slot for the use by other nodes in case of an all optical transmission medium. The release bit is set by the data transmitting node. In case that the transmission medium is
- 30 intermediately converted into the electrical domain, the transmitting node might simply erase the bits indicating a reservation or the like.

- 1 To synchronize the writing of bits or data into a slot, clocking must be provided by either extracting it from the data transmitted on each channel assuming that these data are scrambled or block coded, or by a common clocking channel. The common clocking channel is controlled by one (master) node having means for generating a clock signal. To increase the redundancy of the transmission system, several of the nodes might be equipped to control the clock channel. A common clock channel has the advantage that no specific coding or scrambling of the transmitted data is necessary and that, further, a node remains synchronized even when tuning to another channel.
- 5
- 10 Using the common clock channel as reference, it is possible to provide a node with means for bit, byte, or slot synchronization.  
With an accurate synchronization, the network can be furnished with so-called isochronous slots in case that real time connections require a strict repetition of free slots for certain nodes by effecting a node to generate slots at fixed
- 15 time intervals reserved for only one of the nodes transmitting data to its channel.  
The invention is especially suitable for data transmission systems having an optical transmission medium divided into several channels by wavelength division multiplexing (WDM) as optical fibers are offering a large bandwidth
- 20 for transmission.

#### DESCRIPTION OF THE DRAWINGS

- 25 The invention is described in detail below with reference to the following drawings:
  - 1 FIG. 1A shows an optical ring with several nodes.
  - 30 FIG. 1B illustrates schematically different channels as open loops of the ring of FIG. 1A using WDM.

1      **FIG. 2**     shows the headend section and the transmit section of a node according to the invention.

5      **FIG. 3**     shows means to determine a fairness threshold within a node.

10     **FIG. 4**     shows a clock extraction circuitry of a node.

15     **FIG. 5**     shows components of a node according to the invention when using space division multiplexing for creating different channels.

#### DETAILED DESCRIPTION OF THE INVENTION

A basic network structure is illustrated by FIGs. 1A and 1B. FIG. 1A shows a data transmission system based on an optical ring realized by a single optical fiber 1 with several nodes 2 labeled A...F. While FIG. 1A depicts a specific physical embodiment of the invention, FIG. 1B describing the multi-channel structure of the ring explains the basic idea of the invention in a more abstract and general way. The transmission medium, i.e. the optical fiber 1 of the described embodiment, is divided by wavelength division multiplexing (WDM) into a number of channels 11-17, which are shown in FIG. 1B. Each node is the only destination for data transmitted on its assigned channel. Though each channel is assigned exclusively to only one node, it is possible that one node controls more than one channel. In the described example, one of the nodes 2 labeled with A, the master node, drives two channels 11, 12, one (11) of which is used to provide a common clock signal to all nodes of the ring and for network management purposes, as will be explained below.

Simultaneously, the node is acting as headend of its channel. Thus, it generates free slots 18 and absorbs these slots again after a round-trip on the fiber 1, i.e. after they have passed the other nodes 2 of the transmission system. The direction of the data flow is indicated by arrow 19. In case of an optical ring, the invention establishes all-optical open loops, each starting and

- 1 ending at a node A...F, as the headend is the only point at which a conversion  
of the optical data signals into electronic signals is performed.
- Each node comprises a headend section which controls the channel assigned  
to it and a transmit section for communicating data to the other channels.
- 5 Both parts of a node are schematically described by referring to FIG. 2. In  
case of a single-fiber ring, the complete optical signal of a wavelength channel  
assigned to the node is coupled out and an electrically regenerated signal is  
coupled back by the headend section 21 (enclosed by a dashed line).  
Between the two couplers 211, 212, the respective wavelength is suppressed.
- 10 As optical couplers are readily available to a skilled person and not concern  
of this invention, no specific type is described. During the operation of the  
transmission system, the wavelength assigned to a node remains fixed. By  
using a tuneable coupler 211, it is possible to change the assignation during  
an initializing or a reconfiguration procedure. A tuneable coupler is for  
15 instance implemented by a a tuneable acousto-optical filter that is able to  
separate at least one selected wavelength channel from all WDM channels  
passing the node while suppressing the signals of the selected wavelength  
channel on the optical fiber 1, sufficiently.
- In the preferred embodiment, the coupler is followed by means 213 for  
20 converting an optical signal into an electrical one, e.g. a photo diode or an  
array of photo diodes, and a receive buffer 214 storing the received data to  
prevent a loss of data in case that incoming data rate temporarily exceeds the  
rate in which the data are absorbed by the connected node.
- As all slots are received by the headend, a slot generator 215 is provided to  
25 generate new slots. The electrically generated slots are converted into optical  
signals by an electro-optical converter 216. To implement tuneable  
electro-optical converter 216, a tuneable laser diode or an array of laser  
diodes each having a different wavelength is used. The coupler 212 feeds the  
slots into the optical fiber 1. It is important to note that all data assigned to  
30 other channels or wavelengths pass the headend without conversion.
- Before explaining in detail the control means 217, 218, 219 which have an  
impact on the slot generator 215 of the headend 21, the transmit section 22 of

1 the node will be described. The transmit section 22 of a node comprises a  
broadband coupler 221, a tunable wavelength filter 222 to select the  
wavelength at which a transmission is projected, and an opto-electrical  
converter 223 connected to means 224 for detecting the status of a passing  
5 slot of said channel and for synchronizing the data transmission to a free slot  
ensuring that the data are accurately written in the passing slot at the  
appropriate location, i.e. in the payload field of the slot. To store data in case  
that no free slots are immediately available on the channel, the transmit  
section 22 is additionally provided with a transmit buffer 225. Depending on  
10 the signal received from control 224, either the queue length (QL) as stored in  
register 226 or the data stored in the transmit buffer 225 are transmitted via  
the tuneable electro-optical converter 227, which comprises either a tuneable  
laser diode or an array of laser diodes with different wavelengths. The optical  
signal is coupled into the ring 1 by a coupler 228. A delay line 20 within the  
15 optical fiber 1 between the receiving coupler 211 and the transmitting coupler  
212 of the headend section 21 compensates for the electronic or optical  
processing delay in the control path, thus allowing writing at the accurate  
position of the slot detected by the control means 224.

As mentioned above, it is an important aspect of the invention that the  
20 headend part of each node exclusively controls the data flow on its channel by  
generating slots to which all other nodes can contribute data signals, i.e.  
payloads, having said node as destination.

Besides the slot generation, each headend preferably comprises further  
means 217, 218, 219 to control the access to its channel. The fairness control  
25 217 guarantees that all nodes tuned to the channel obtain an equal share of  
the channel throughput capability. The flow control 218 regulates the data  
flow such that the receiver can always accept all the data transmitted. And  
the congestion control 219 prevents data units from being lost due to a  
completely filled receive buffer. The described example of the invention  
30 achieves these controls by using four bits to indicate the status of a slot.

A busy bit indicates that the slot cannot be accessed by a node for  
transmitting data. A reserve bit is used to mark a slot as reserved in

1 connection with the fairness control. And a guarantee bit is set to indicate a priority reservation. In addition, it can be used together with the aforementioned reserve bit to identify a guaranteed bandwidth slot. A guaranteed bandwidth is required by real time applications, such as  
5 interactive voice and video transmission or remote process control. The fourth bit, i.e. the release bit, indicates that the reservation due to any of the three other bits is cancelled and, hence, the slot can be accessed by any node. The release bit gains importance in the transient phase wherein the demand for slots decreases after a period of excess demand; reserved or  
10 guaranteed slots which are not needed by the transmitting nodes become available to the other nodes on the ring. Apparently, only the busy and reserve bits are necessary for fairness, flow, and congestion control. The other two bits are used advantageously for specific and advanced purposes.  
In the following, the fairness control will be described in detail. It is the scope  
15 of the fairness control to reduce the impact of the position of a node within the bus or ring topology. Without a fairness control the first node situated 'downstream' of the headend node of the considered channel has free access to every slot generated by the channel's headend effectively blocking the data transmission of all following nodes for the period it is transmitting. To  
20 establish a fairness control, the headend of the channel periodically issues a special slot, i.e. the reserve command. The periods are referred to as reservation cycles. Apart from short rings carrying less than around hundred slots simultaneously on the transmission medium, a reservation cycle is a few slot time units larger than the round-trip delay. The reserve command  
25 collects from each node currently tuned to the channel the amount of data, i.e. the queue length (QL), waiting for transmission on that channel.  
Further, the entries to the reserve command must not be identified by addresses indicating the transmitting node. Only an additional flag is required to notify whether a node specifies its queue length for the first time  
30 or not. Before the headend issues the reserve command, it marks all empty entries by a zero and all entries used in the previous reserve command by a one. A node making an entry for the first time detects the first location in the

- 1 reserve command marked by a zero and stores the position of said location. Further, the current value of QL is written at this location. The node continues to use the marked location in the reserve command until it ceases to transmit on the channel.
  - 5 If the sum of the required slots as reflected by incoming queue lengths exceeds the transmission capacity during a reservation cycle, the fairness control 217 within the headend section 21 of a node determines a fairness threshold value (TH). Means for determining a threshold value within microseconds is described, for example, in the European application
  - 10 No.93810215.9, having the title 'Apparatus for Determining the Optimal Value of a Control Parameter and Use of the Apparatus'. The method described in the aforementioned application is based on treating the demand QL for each node as piecewise linear function using the number of slots as independent variable. To accelerate the determination of the threshold, the second
  - 15 derivatives of these functions are summed rather than the values QL, themselves. Due to the simple structure of the functions, the second derivatives equal +1 at the position zero (slots) and -1 at the position QL (slots) and zero, elsewhere.
- To determine a threshold for the next reservation cycle, firstly, each node has
- 20 means to determine the actual demand of a transmitting node taking into account that that node has transmitted data during the current reservation cycle after writing his demand to the currently received reserve command. The amount of data already transmitted either equals the amount of data QL(old) reported by each node in the previous cycle or the previous threshold
  - 25 value TH; this amount is subtracted from the demand of each node gathered from the current reserve command. Secondly, these differences, as representing the actual demand of each node for the considered channel, are sequentially supplied via the address line 31 to a gate array GA and a random access memory RAM as shown in FIG. 3.
  - 30 For adding the second derivatives only the gate array GA, the RAM, and the incrementer/decrementer 33 of the whole circuit are active. The value zero and the actual demanded number of slots as calculated are applied via

- 1 address lines 31 to the gate array GA and the random access memory RAM  
for each node, consecutively. In the described example, the input of the  
second derivative is done by the help of the incrementer/decrementer 33, as  
the slope of each function only changes by an amount of 1. The contents of  
5 the memory location in the RAM at the address zero is incremented by 1,  
whereas the value of the other memory locations at the addresses QL is  
decremented by 1 for request entries. During this summation process the  
gate array GA keeps track of all addresses at which an entry has been made.  
After the input from all nodes has been stored, accordingly, the cycle length  
10 values just above and below the desired cycle length, together with the  
corresponding threshold values are computed.
- The gate array, when strobed, will consecutively output all the addresses at  
which a value had been entered. By means of a subtracter circuit 34 the  
difference between consecutive addresses is obtained.
- 15 The output from the gate array is also used to address the RAM. The RAM  
will output the sums of the second derivatives as stored at the addressed  
memory locations. This sum corresponds to a difference in the slope of the  
sum S of the requested slots. The differences in slope are integrated by  
means of an adder 36 and a register 37, resulting in the first derivative S\* of  
20 S.

To perform the second integration these slope values S\* are multiplied in the  
following circuit 38 with the value from the subtracter 34. This operation  
results in the difference between two consecutive values at upper and lower  
end of a linear segment of the sum S. By summing all these difference values  
25 with the help of another adder 39 and a register 310 all values of the function  
S itself are consecutively obtained.

As soon as the calculated cycle length value exceeds the desired cycle length  
reference value, stored in register 312, a load pulse stores the cycle length  
just above and just below the desired value in the registers 316 and 315,  
30 together with the corresponding threshold values, which are stored in  
registers 314 and 313. At this point, one of the two threshold values or a  
value derived by linear interpolation between the two values may be selected.

- 1 Since the multiplier is the slowest element in the chain, and since multipliers exhibit multiplication times of 50 ns or less, the threshold can easily be derived in less than 1  $\mu$ s (assuming 16 active nodes).  
The threshold value gives the maximum number of slots available to a node
- 5 during the following reservation cycle. It is broadcast to the nodes together with the next reserve command. A corresponding number of slots in the reservation cycle are marked by the headend as reserved by setting the reserve bit to "1". If a threshold value other than zero is given, every transmitting node stores said value and writes its current queue length (QL) into the reserve command. A node is allowed to access free reserved slots up to either the threshold value or the QL value written in the preceding reserve command, whatever is less. For that purpose, the QL value as specified in the reserve command is stored by the node. The following components of the transmit section are used to handle the reserve command.
- 10 The QL value, written to the new reserve command is stored in a first of two pipelined registers, while the old QL value written to the previous reserve command is pushed into the second register. A comparator compares the old QL value to the new TH value received from the new reserve command and controls a multiplexer which stores the minimum of either QL(old) or TH into a counter. This counter keeps track of the number of slots transmitted by the node within the current reservation cycle and terminates the transmission when the stored value is decremented to zero.
- 15 Assuming for example four nodes active on the considered channel with a demand of QL = 10, 5, 12, and 3, respectively, the reserve command gathers a total demand of 30 exceeding a predetermined reference value, e.g. 25. The headend determines a threshold value of 9 resulting in a cycle length for the following reservation cycle of 26. The reserve command issued next reports the threshold value 9 to the control means 224 which regulate the data transmission of a node to the channel. The nodes, thus, occupy 9, 5, 9, and 3
- 20 slots of the next reservation cycle, respectively.
- 25 The reserve command which broadcast the TH of 9 to the nodes simultaneously collects a demand of QL = 22, 7, 20, and 15 of the nodes for

1 the next cycle . The headend determines the actual demand of the nodes for  
the next cycle by subtracting the slots transmitted during the current cycle.  
The remaining demand becomes, therefore, 22-9, 7-5, 20-9, and 15-3, for the  
four nodes, giving a sum of 38. Thus, the next cycle starts with a threshold of  
5 8 and, in accordance with the remaining demand of the nodes, a cycle length  
of 26 slots. If a node does not make use of the (full) amount of reserved slots,  
because it was able to transmit to a non-reserved slot in the meantime, the  
control 214 transmits a "1" to the release bit position of an unused slot,  
allowing other nodes to transmit data in these slots. The threshold  
10 determination is repeated until the capacity reference value is no longer  
exceeded by the accumulated demand of the nodes. In this case, the TH is  
set to a special value, e.g. 0, indicating that the access limitation is cancelled  
for the following cycle. To prevent a frequent change between periods of  
reserved and free access, it is proposed to define the capacity reference to a  
15 value below the 100% capacity of the system.

In order to control the data flow, the headend 21 is able to mark a certain  
fraction of the generated slots as busy instead of free. As shown in FIG.2, the  
flow control means 218 monitor the content of the receive buffer 214. When  
this content reaches a critical value, the slot generator 215 throttles the  
20 generation of free slots. This throttling does not disturb the data transmission  
to other destinations, because these transmission occur in different channels.  
Instead from the buffer 214, the flow control 218 may receive its input signal  
also from another circuitry when, for instance, the receiving node is an access  
point to a currently congested network, e.g. a bridge or a router.

25 A congestion control 219 prevents a loss of data due to an overflow of the  
receive buffer 214 in the headend. The congestion control causes the slot  
generator 215 to issue an special slot, i.e. the congestion command. The  
detection of a congestion command by the other nodes prevents them from  
transmitting further data, until the congestion command is rendered into a  
30 go-ahead command by the headend. The congestion command is issued by  
the headend when a busy slot arrives and the receive buffer is full. After the  
opto-electrical conversion 213, the busy slot and all following slot are no

- 1 longer switched to the buffer 214 but redirected to the slot generator 215, which fills the freshly generated slots with the data of the received slot. Thus, the slots are relayed for another round-trip around the loop formed by the optical fiber 1. All other slots follow, independently of the buffer having  
5 gained free capacity in the meantime, until the congestion command returns to the headend. When it returns and the receive buffer has sufficiently been emptied, the command is converted into a go-ahead command, and the recycled busy slots are received, else they are forced to pass the ring, again. The slots remain in their correct sequence.
- 10 For the synchronization of the data transmission, the system preferably provided with a common clock channel controlled by the master node. In case of a WDM optical ring, a specific wavelength  $\lambda_0$  is designated as clocking channel for all nodes. The common clock channel provides a bit, word, and slot synchronization, as shown in FIG.4, as well as a timing frame, e.g. of 125  
15  $\mu$ s, for real-time applications. In addition, it can be used as service channel for network management. A coded diphase coding scheme can, for instance, be used to ease the clock extraction. From the clock channel 11 carrying the coded diphase clock signal, a part of said signal is coupled out via the coupler 42 and transduced into an electrical signal by the opto-electrical converter 43.
- 20 By using a phase-locked loop 44, the bit clock is detected. A serial-to-parallel converter 45 converts the bit stream into an eight-bit wide format, while a CRC (Cyclic Redundancy Check) checker 46 keeps track of the slot boundaries. The CRC checker is also used to periodically reset a counter 47. If it is not reset, it produces a carry output which causes the serial-to-parallel converter 45 to  
25 skip a bit position. This process is repeated until the byte boundary is found. Thus, a bit clock, a word clock, and a slot boundary clock signal can be extracted and exploited for the transmission of the data to the ring. The common clock channel simplifies the receiver and transmitter of the nodes as no scrambler/discrambler or encoding/decoding hardware is required.
- 30 Further, all transmitting channels are identically synchronized and, thus, every transmitter can tune to another channel without a resynchronization. Only a

- 1 phase correction is needed, when changing the wavelength, since signals of  
different wavelengths propagate with different speeds.
- The master node and the clock channel are used to allocate the wavelength  
channels to the nodes of the system, i.e. to tune the headend of a node to a  
5 certain wavelength at network initialization time or when a network  
reconfiguration is executed. Other network management tasks can be  
additionally performed by the master node. For example, it is possible to  
change the wavelength assigned to a node in a reconfiguration of the whole  
transmission system by sending control signals to the tuneable devices in the  
10 headend section of each node.
- A particular write pattern is applied to the four status bits, i.e. the busy,  
release, reserve, and guarantee bit, ensuring that bits are erased (or nullified)  
only at the headend section. The headend generates in the described  
example five different types of slots: If none of the status bits is set (to "1"),  
15 the slot is a free slot. A "1" at the reserve bit position is used to indicate a  
free reserved slot, while an additional "1" at the guarantee bit position assigns  
a free guaranteed slot. If a "1" is set only at the guarantee bit position, a free  
priority slot is indicated. An Isochronous channel slot can be defined by  
having a "1" at the busy and guarantee bit position. Whereas these bits are  
20 set by the headend which generates the slots, the transmitting node mark a  
used slot as busy by setting the busy bit. Further, a node can indicate that  
unused reserved, guaranteed, or priority slots are made free for being used  
by any node by setting the release bit to "1". These free released slots are  
marked busy by setting the busy bit. In the described scheme, bits are only  
25 set but not deleted (except at the receiving node) providing an advantage in  
optical signal processing where erasing a light signal on a particular  
wavelength channel from the transmission medium is more difficult to achieve  
than adding a light signal.

FIG. 5 shows the another example of the invention wherein the multiple  
30 channels are realized by cables with parallel optical fibers 51. In this  
example, the headend section comprises an optical switch 56 operated either  
manually or electronically in case that the network is reconfigured. In the

1 transmit section, the tunable filters and transmitting lasers are replaced by  
detector and laser arrays 52, 53 controlled by electronic multiplexing means  
54, 55. By implementing these changes, the medium access control scheme of  
the invention remains basically unchanged.

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**SUBSTITUTE SHEET**

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**CLAIMS**

1. A node (2) in a digital data transmission system with a plurality of nodes and a transmission medium (1) dividable into a plurality of channels (11-17) connecting said nodes, with each of said nodes exclusively assigned to at least one of said channels (11-17) as a data receiving node, said node (2) having coupling means (22) to transmit data to channels assigned to other nodes, and comprising  
5 slot generating means (215) able to generate slots (18) in which said nodes can asynchronously insert the data to be transmitted to said node (2) and able to mark generated slots as reserved,  
fairness control means (217) for controlling said slot generator means (215) to provide a balanced access to said slots (18) for all nodes (2)  
10 having data to transmit on said channel by determining the amount of data to be transmitted and causing said slot generator means (215) to mark generated slots as reserved, and  
15 transmission control means (224) for detecting a reserved slot and for controlling said coupling means (22) to prevent a transmission to a reserved slot.
- 20 2. Node in accordance with claim 1, wherein the fairness control means (217) comprises  
first means for controlling the slot generating means (215) as to periodically generate a poll slot (reserve command) which broadcasts the threshold value (TH) for its channel to the other nodes (2) and gathers a value (QL) indicating the amount of data waiting to be transmitted on its channel from each of the other nodes (2) tuned to its channel, and  
25 second means (30) for determining a threshold value (TH) for the next reserve command, and  
30 wherein the transmission control means (224) comprises means for determining the amount of data to be transmitted to another node

- 1       according to said threshold value (TH) sent by said other node in said poll  
slot (reserve command).
- 5       3. Node in accordance with claim 1, comprising buffer means (214) for  
storing the data received from the transmission medium (1) and flow  
control means (218) for controlling the slot generating means (215) in  
dependence on the extend to which said buffer means (214) is occupied.
- 10      4. Node in accordance with claim 1, comprising buffer means (214) for  
storing the received data and congestion control means (219) for  
controlling the slot generating means (215) in dependence on the extend  
to which said buffer means (214) is occupied and using the channel as  
intermediate storage.
- 15      5. Node in accordance with claim 1, comprising buffer means (214) for  
storing the received data and congestion control means (219) for  
controlling the slot generating means (215) in dependence on the extend  
to which said buffer means (214) is occupied and using the channel as  
intermediate storage, wherein said congestion control means (219)  
20      comprises means for controlling the slot generating means (215) to  
generate a slot (congestion command) causing all nodes to stop  
transmission on its channel and means for relaying received slots (18)  
back to the transmission medium (1).
- 25      6. Node in accordance with claim 1, comprising priority access control  
means or guaranteed bandwidth control means for controlling the slot  
generating means (215) as to periodically generate a poll slot collecting  
the demand for priority or guaranteed bandwidth slots to be transmitted  
30      on its channel node from each of the other nodes tuned to its channel and  
to generate slots marked with a priority or guaranteed status, depending  
on the number of demanded priority or guaranteed slots and the capacity  
of its channel.

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7. Node in accordance with claim 1, wherein the transmission control means (224) comprises means for marking a reserved slot as released.
- 5 8. Node in accordance with claim 1, comprising means for generating a clock signal on one (clock) channel (11).
9. Node in accordance with claim 1, comprising means for bit synchronization (44), byte synchronization (45), or slot synchronization (46), using a common clock channel (11) as reference.  
10
10. Card to be inserted into a computer system, comprising a node in accordance with one or more of claims 1 - 9.
- 15 11. Transmission system comprising a plurality of nodes in accordance with one or more of claims 1 - 9.
12. Transmission system comprising a plurality of nodes in accordance with one or more of claims 1 - 9, having an optical transmission medium (1) divided into several channels (11-17) by wavelength multiplexing division (WDM).  
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**SUBSTITUTE SHEET**

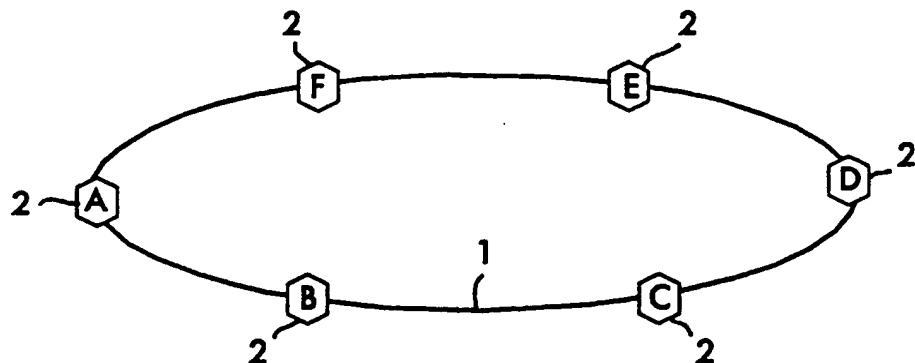


FIG.1A

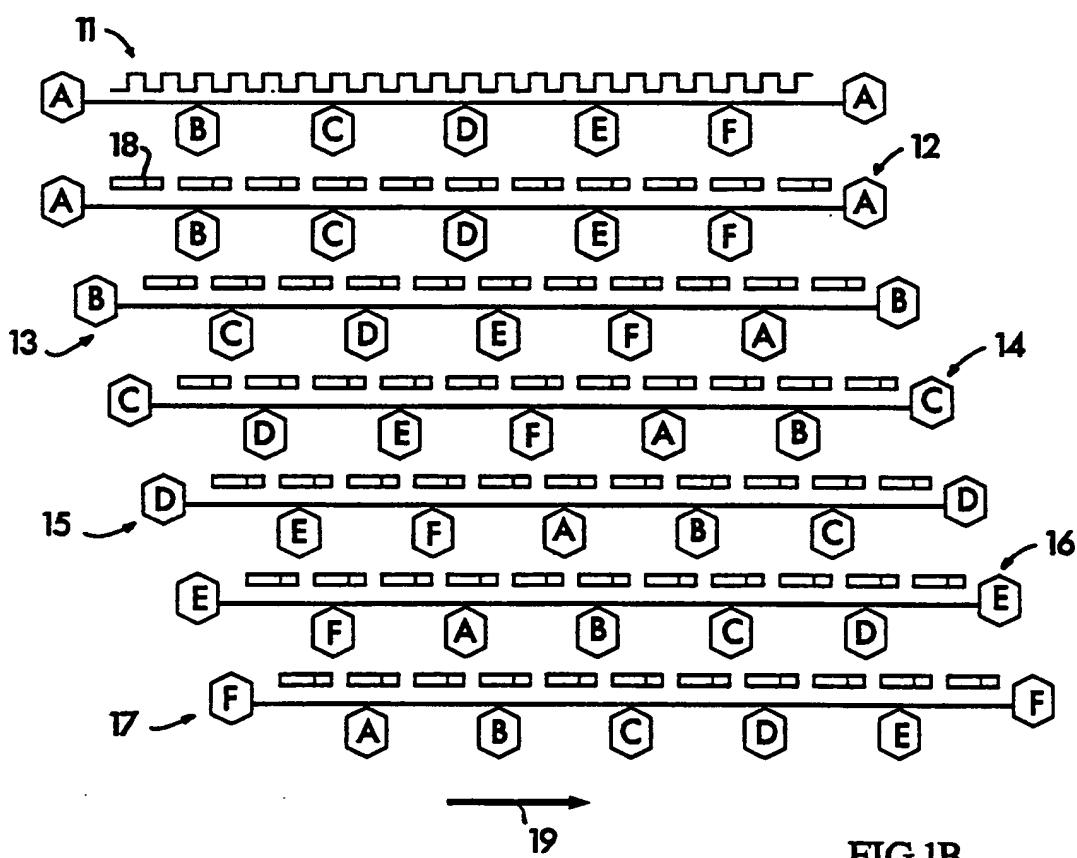
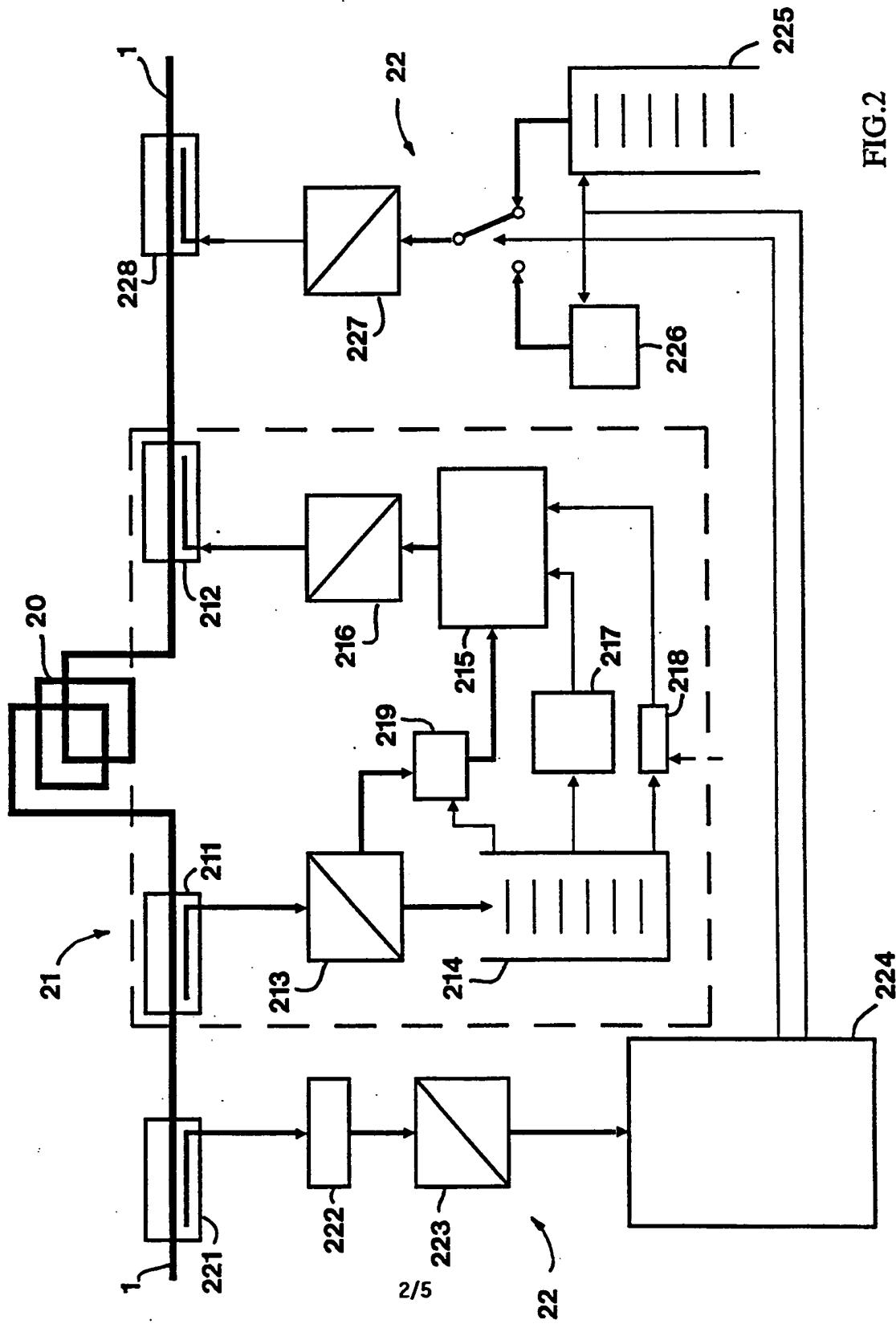


FIG.1B



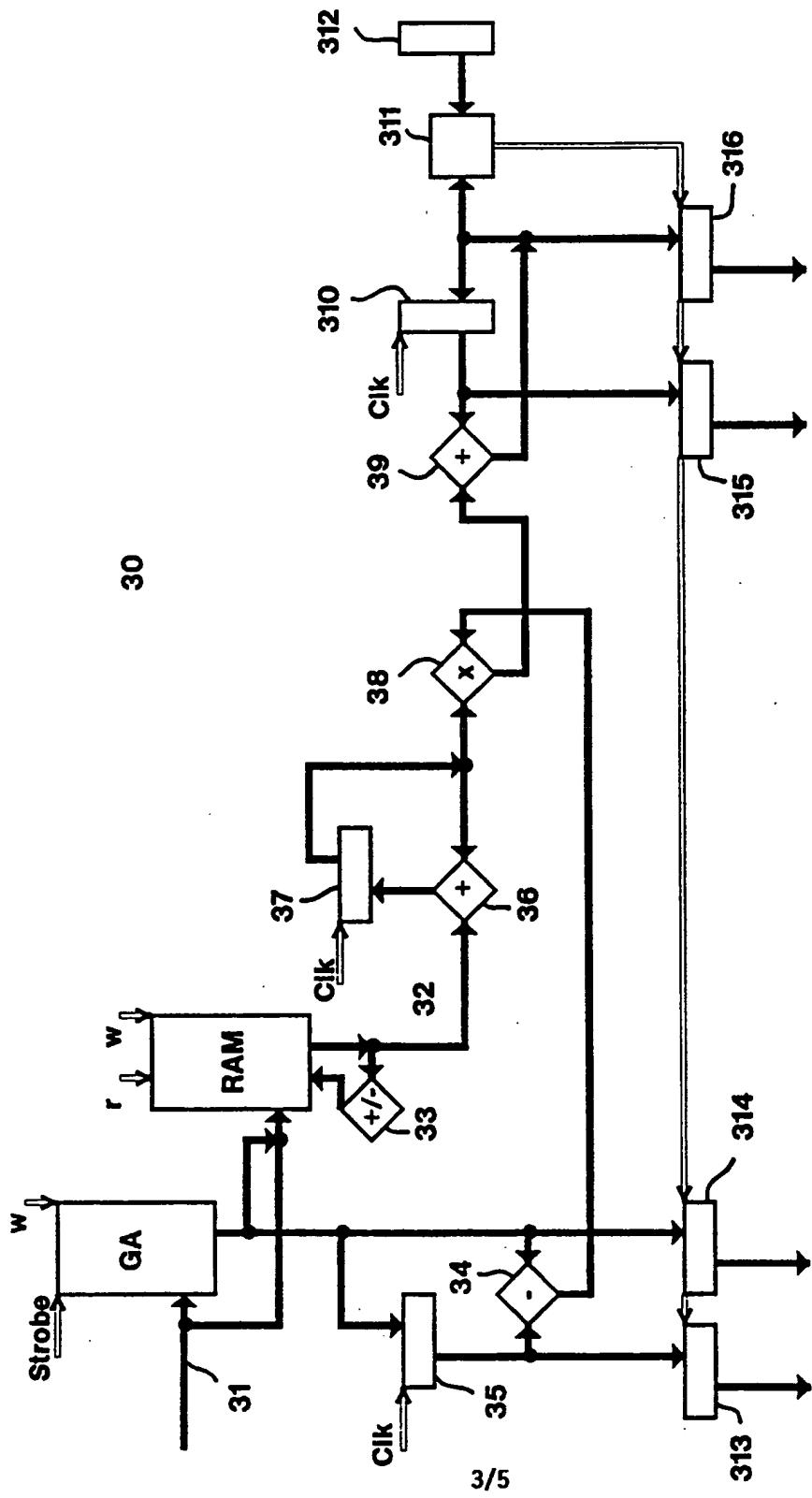
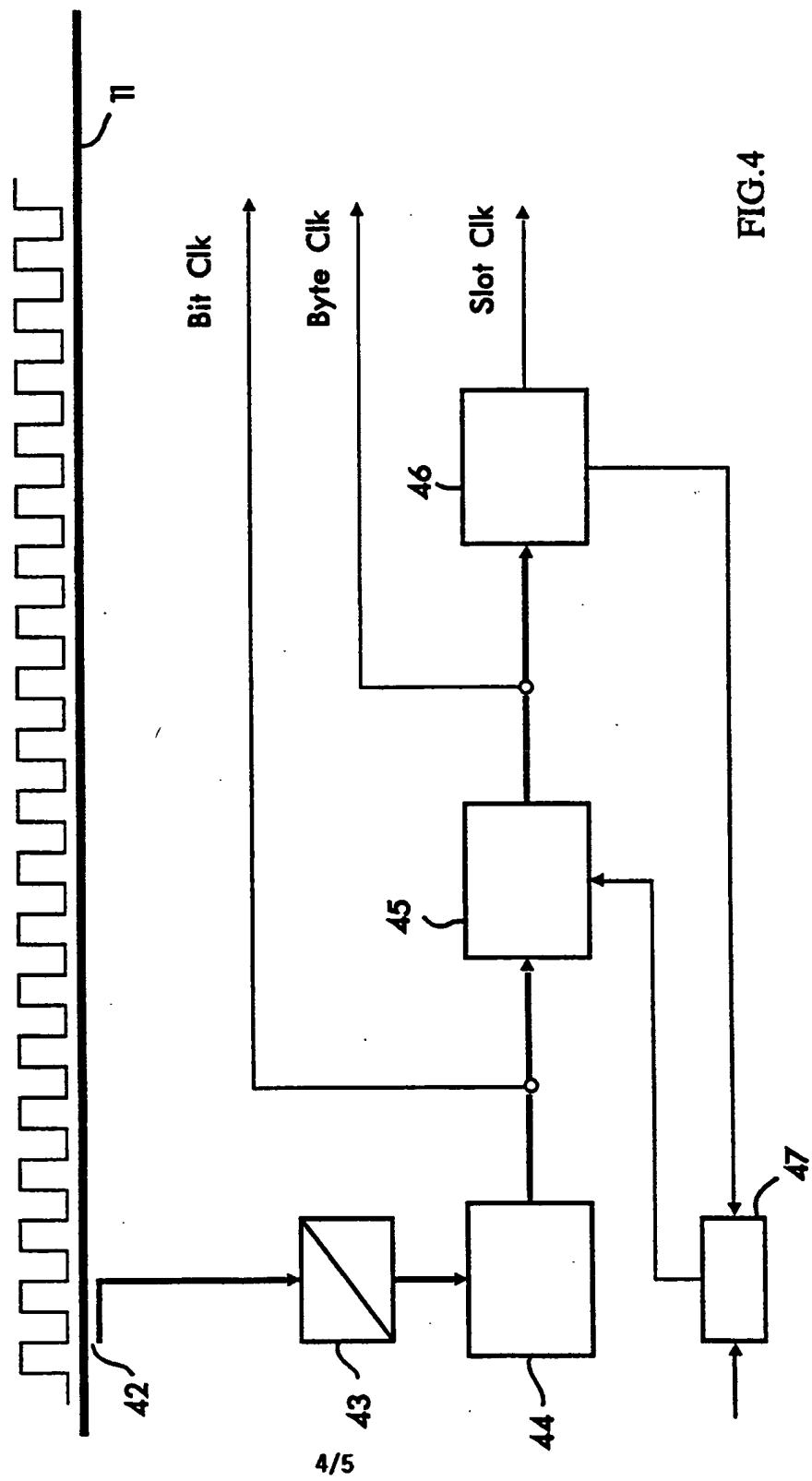
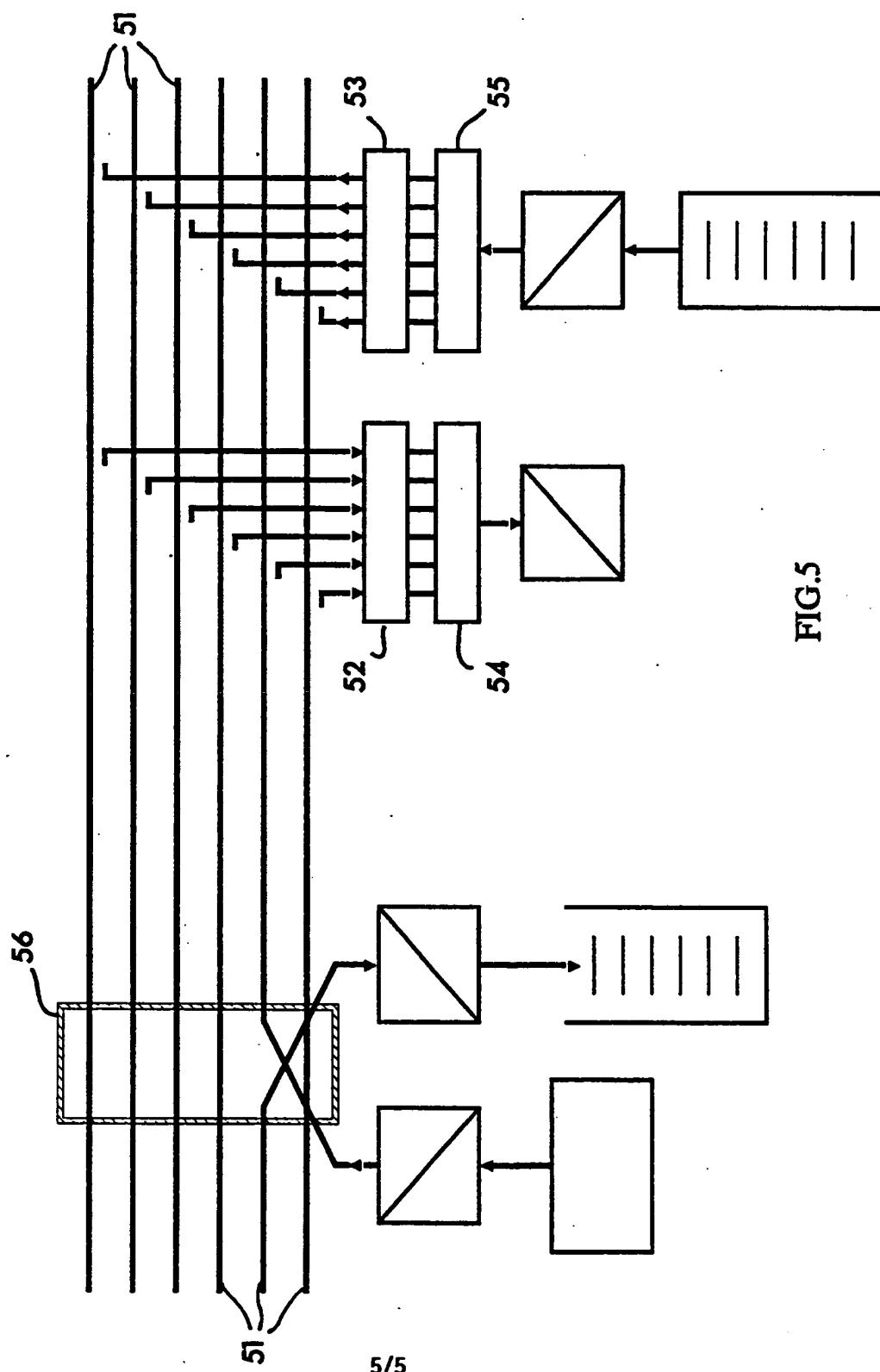


FIG.3





## INTERNATIONAL SEARCH REPORT

International application No. PCT/EP 93/02881
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A. CLASSIFICATION OF SUBJECT MATTER IPC 6 H04L12/42
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According to International Patent Classification (IPC) or to both national classification and IPC
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B. FIELDS SEARCHED
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Minimum documentation searched (classification system followed by classification symbols) IPC 6 H04L
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
---

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	PROCEEDINGS OF THE NATIONAL ELECTRONICS CONFERENCE, vol 1.36, 1982, OAK BROOK, ILLINOIS US pages 356 - 362 J.A. DAVIS ET AL. 'A LOCAL NETWORK FOR EXPERIMENT SUPPORT' see page 357, right column, line 38 - line 59 ---	1,7,9,10
Y	EP,A,0 332 197 (FUJITSU LIMITED) 13 September 1989 see claim 1 see figure 9 ---	1,7,9,10
A	EP,A,0 505 658 (INTERNATIONAL BUSINESS MACHINES CORPORATION) 30 September 1992 see page 2, line 12 - line 40 see page 3, line 8 - page 4, line 52 ---	1-12 -/-

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

## \* Special categories of cited documents :

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- \*'Z' document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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29 June 1994

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## Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+ 31-70) 340-3016

## Authorized officer

Perez Perez, J

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/EP 93/02881

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE,C,36 03 907 (STEIN GMBH) 16 April 1987 see abstract see claim 1 -----	1,2

1

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.  
PCT/EP 93/02881

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0332197	13-09-89	JP-A-	2168797	28-06-90
		US-A-	4965790	23-10-90
EP-A-0505658	30-09-92	JP-A-	6030007	04-02-94
		US-A-	5276682	04-01-94
DE-C-3603907	16-04-87	NONE		